

WHAT IS CLAIMED IS:

1 1. A microfluidic device for capacitive pressure sensing, the device
2 comprising:
3 a fluid channel including an inlet at a first end and an outlet at a second end;
4 a cavity region coupled to the fluid channel;
5 a polymer based membrane coupled between the fluid channel and the cavity
6 region;
7 a first capacitor electrode coupled to the membrane;
8 a second capacitor electrode coupled to the cavity region and physically
9 separated from the first capacitor electrode by at least the cavity region;
10 an electrical power source coupled between the first capacitor electrode and
11 the second capacitor electrode and causing an electric field at least within the cavity region;
12 wherein the polymer based membrane includes a polymer.

1 2. The device of claim 1 wherein the polymer comprises a material
2 selected from a group consisting of Parylene, polyimide, and silicone.

1 3. The device of claim 2 wherein the polymer comprises Parylene.

1 4. The device of claim 1 wherein the first capacitor electrode is
2 embedded within the polymer based membrane.

1 5. The device of claim 1, and further comprising:
2 a substrate, the second capacitor electrode being disposed on the substrate.

1 6. The device of claim 5 wherein the substrate comprises a material
2 selected from silicon and glass.

1 7. The device of claim 5, and further comprising:
2 a layer of silicon oxide, the layer of silicon oxide being disposed between the
3 second capacitor electrode and the substrate.

1 8. The device of claim 1 wherein the fluid channel contains at least a
2 liquid.

1 9. The device of claim 1 wherein the fluid channel contains at least a gas.

- 1 10. The device of claim 1 wherein the cavity region contains at least a gas.
- 1 11. The device of claim 1 wherein the cavity region contains at least a
2 liquid.
- 1 12. The device of claim 1 wherein each of the first capacitor electrode and
2 the second capacitor electrode comprises a material selected from a group consisting of gold,
3 aluminum, platinum, chrome, titanium, and doped polysilicon.
- 1 13. The device of claim 1 wherein the fluid channel is associated with a
2 fluid pressure;
3 wherein the fluid pressure is associated with a first shape of the polymer based
4 membrane;
5 wherein the first shape is associated with a capacitance of a capacitor
6 including the first capacitor electrode, the second capacitor electrode and the cavity region.
- 1 14. The device of claim 1 wherein the fluid channels is characterized by a
2 channel height ranging from 0.1 to 100 microns.
- 1 15. The device of claim 14 wherein the channel height ranges from 1 to 10
2 microns.
- 1 16. The device of claim 1 wherein the polymer based membrane is
2 characterized by a membrane thickness ranging from 0.1 to 10 microns.
- 1 17. The device of claim 16 wherein the membrane thickness ranges from 1
2 to 5 microns.
- 1 18. The device of claim 1 wherein the polymer based membrane is
2 characterized by a membrane diameter ranging from 10 to 1000 microns.
- 1 19. The device of claim 18 wherein the membrane diameter is equal to 200
2 microns.
- 1 20. A microfluidic device for capacitive fluidic sensing, the device
2 comprising:

3 a fluid channel including an inlet at a first end and an outlet at a second end,
4 the fluid channel being associated with a first polymer based layer and a second polymer
5 based layer;

6 a first capacitor electrode coupled to the first polymer based layer;
7 a second capacitor electrode coupled to the second polymer based layer and
8 physically separated from the first capacitor electrode by at least the fluid channel;

9 an electrical power source coupled between the first capacitor electrode and
10 the second capacitor electrode and causing an electric field at least within the fluid channel;

11 wherein the first polymer based layer includes a first polymer;

12 wherein the second polymer based layer includes a second polymer.

1 21. The device of claim 20 wherein each of the first polymer and the
2 second polymer comprises a material selected from a group consisting of Parylene,
3 polyimide, and silicone.

1 22. The device of claim 21 wherein each of the first polymer and the
2 second polymer comprises Parylene.

1 23. The device of claim 20, and further comprising:
2 a substrate, the second capacitor electrode being disposed on the substrate.

1 24. The device of claim 23 wherein the substrate comprises a material
2 selected from silicon and glass.

1 25. The device of claim 23, and further comprising:
2 a layer of silicon oxide, the layer of silicon oxide being disposed between the
3 second capacitor electrode and the substrate.

1 26. The device of claim 20 wherein the fluid channel contains at least a
2 liquid.

1 27. The device of claim 20 wherein the fluid channel contains at least a
2 gas.

1 28. The device of claim 20 wherein each of the first capacitor electrode
2 and the second capacitor electrode comprises a material selected from a group consisting of
3 gold, aluminum, platinum, chrome, titanium, and doped polysilicon.

1 29. The device of claim 20 wherein the fluid channels is characterized by a
2 channel height ranging from 0.1 to 100 microns.

1 30. The device of claim 29 wherein the channel height is ranging from 1 to
2 10 microns.

1 31. The device of claim 20 wherein the fluid channels is characterized by a
2 channel width ranging from 1 to 1000 microns.

1 32. The device of claim 31 wherein the channel width is equal to 100
2 microns.

1 33. The device of claim 20 wherein
2 the fluid channel is associated with a fluid volume;
3 the fluid volume is associated with a capacitance of a capacitor including the
4 first capacitor electrode, the second capacitor and the fluid channel.

1 34. The device of claim 20 wherein
2 the fluid channel is associated with a fluid;
3 the fluid is associated with a capacitance of a capacitor including the first
4 capacitor electrode, the second capacitor and the fluid channel;
5 the capacitance is associated with at least a characteristic of the fluid.

1 35. The device of claim 34 wherein the characteristic of the fluid is a
2 dielectric constant.

1 36. The device of claim 34 wherein the characteristic of the fluid is a
2 conductivity.

1 37. The device of claim 34 wherein the fluid comprises a mixture of a
2 plurality of solvents.

1 38. The device of claim 37 wherein the mixture comprises at least one
2 solvent selected from a group consisting of water, IPA, acetonitrile, acetone, methanol, and
3 ethanol.

1 39. The device of claim 34 wherein the characteristic of the fluid is a
2 composition of the fluid.

1 40. A microfluidic device for capacitive fluidic sensing, the device
2 comprising:
3 a fluid channel including an inlet at a first end and an outlet at a second end,
4 the fluid channel being associated with a first polymer based layer and a second polymer
5 based layer;
6 a first capacitor electrode coupled to the first polymer based layer;
7 a second capacitor electrode coupled to the first polymer based layer and
8 physically separated from the first capacitor electrode;
9 an electrical power source coupled between the first capacitor electrode and
10 the second capacitor electrode and causing an electric field at least within the fluid channel;
11 wherein the first polymer based layer includes a first polymer;
12 wherein the second polymer based layer includes a second polymer.

1 41. The device of claim 40 wherein each of the first polymer and the
2 second polymer comprises a material selected from a group consisting of Parylene,
3 polyimide, and silicone.

1 42. The device of claim 41 wherein each of the first polymer and the
2 second polymer comprises Parylene.

1 43. The device of claim 40, and further comprising:
2 a substrate, the first capacitor electrode and the second capacitor electrode
3 being disposed on the substrate.

1 44. The device of claim 43 wherein the substrate comprises a material
2 selected from silicon and glass.

1 45. The device of claim 43, and further comprising:
2 a layer of silicon oxide, the layer of silicon oxide being disposed between the
3 second capacitor electrode and the substrate.

1 46. The device of claim 40 wherein the fluid channel contains at least a
2 liquid.

1 47. The device of claim 40 wherein the fluid channel contains at least a
2 gas.

1 48. The device of claim 40 wherein each of the first capacitor electrode
2 and the second capacitor electrode comprises a material selected from a group consisting of
3 gold, aluminum, platinum, chrome, titanium, and doped polysilicon.

1 49. The device of claim 40 wherein the fluid channels is characterized by a
2 channel height ranging from 0.1 to 100 microns.

1 50. The device of claim 49 wherein the channel height ranges from 1 to 10
2 microns.

1 51. The device of claim 40 wherein the fluid channels is characterized by a
2 channel width ranging from 1 to 1000 microns.

1 52. The device of claim 51 wherein the channel width is equal to 100
2 microns.

1 53. The device of claim 40 wherein the first capacitor electrode and the
2 second capacitor electrode are interlocking.

1 54. The device of claim 40 wherein each of the first polymer layer and the
2 second polymer based layer is characterized by a thickness ranging form 0.1 to 10 microns.

1 55. The device of claim 40 wherein
2 the fluid channel is associated with a fluid volume;
3 the fluid volume is associated with a capacitance of a capacitor including the
4 first capacitor electrode, the second capacitor and the fluid channel;
5 the capacitance is associated with a volume resolution smaller than 5 pL.

1 56. The device of claim 40 wherein
2 the fluid channel is associated with a fluid;
3 the fluid is associated with a capacitance of a capacitor including the first
4 capacitor electrode, the second capacitor and the fluid channel;
5 the capacitance is associated with at least a characteristic of the fluid.

1 57. The device of claim 56 wherein the characteristic of the fluid is a
2 dielectric constant.

1 58. The device of claim 56 wherein the characteristic of the fluid is a
2 conductivity.

1 59. The device of claim 56 wherein the fluid comprises a mixture of a
2 plurality of solvents.

1 60. The device of claim 59 wherein the mixture comprises at least one
2 solvent selected from a group consisting of water, IPA, acetonitrile, acetone, methanol, and
3 ethanol.

1 61. The device of claim 56 wherein the characteristic of the fluid is a
2 composition of the fluid.

1 62. The device of claim 40 wherein the first capacitor electrode and the
2 second capacitor electrode are configured as parallel plates.

1 63. A method for fabricating a capacitive fluidic sensing device, the
2 method comprising:

3 providing a substrate;

4 patterning a first electrode layer to form at least a first electrode overlying the
5 substrate;

6 forming a first polymer based layer overlying the first electrode;

7 forming a first sacrificial layer overlying the first polymer based layer;

8 forming a second polymer based layer overlying the first sacrificial layer;

9 patterning a second electrode layer to form at least a second electrode over the
10 second polymer based layer, the second electrode being associated with the first electrode;

11 forming a third polymer based layer overlying the second electrode to
12 sandwich the second electrode between the second polymer based layer and the third polymer
13 based layer;

14 forming a second sacrificial layer overlying the third polymer based layer;

15 forming a fourth polymer based layer overlying the second sacrificial layer;

16 releasing the first sacrificial layer between the first polymer based layer and
17 the second polymer based layer; and

18 releasing the second sacrificial layer between the second polymer based layer
19 and the third polymer based layer.

1 64. The method of claim 63 wherein:
2 the first polymer based layer, the second polymer based layer, the third
3 polymer based layer, and the fourth polymer based layer are formed at a temperature of less
4 than 120°C; and
5 the first sacrificial layer and the second sacrificial layer are formed and
6 released at a temperature of less than 120°C.

1 65. The method of claim 63 wherein the first polymer based layer, the
2 second polymer based layer, the third polymer based layer, and the fourth polymer based
3 layer are provided at room temperature using chemical vapor deposition of Parylene.

1 66. A method for fabricating a capacitive fluidic sensing device, the
2 method comprising:
3 providing a substrate;
4 patterning a first electrode layer to form at least a first electrode overlying the
5 substrate;
6 forming a first polymer based layer overlying the first electrode;
7 forming a first sacrificial layer overlying the first polymer based layer;
8 forming a second polymer based layer overlying the first sacrificial layer;
9 patterning a second electrode layer to form at least a second electrode over the
10 second polymer based layer, the second electrode being associated with the first electrode;
11 forming a third polymer based layer overlying the second electrode to
12 sandwich the second electrode between the second polymer based layer and the third polymer
13 based layer;
14 releasing the first sacrificial layer between the first polymer based layer and
15 the second polymer based layer.

1 67. The method of claim 66 wherein:
2 the first polymer based layer, the second polymer based layer, and the third
3 polymer based layer are formed at a temperature of less than 120°C; and
4 the first sacrificial layer is formed and released at a temperature of less than
5 120°C.

1 68. The method of claim 66 wherein the first polymer based layer, the
2 second polymer based layer, and third polymer based layer are provided at room temperature
3 using chemical vapor deposition of Parylene.

1 69. A method for fabricating a capacitive fluidic sensing device, the
2 method comprising:
3 providing a substrate;
4 patterning a first electrode layer to form at least a first electrode and a second
5 electrode overlying the substrate, the second electrode being associated with the first
6 electrode;
7 forming a first polymer based layer overlying the first electrode and the
8 second electrode;
9 forming a first sacrificial layer overlying the first polymer based layer;
10 forming a second polymer based layer overlying the first sacrificial layer;
11 releasing the first sacrificial layer between the first polymer based layer and
12 the second polymer based layer;
13 wherein the first electrode and the second electrode are two interlocking and
14 physically separated electrodes.

1 70. The method of claim 69 wherein:
2 the first polymer based layer and the second polymer based layer are formed at
3 a temperature of less than 120°C; and
4 the first sacrificial layer is formed and released at a temperature of less than
5 120°C.

1 71. The method of claim 69 wherein the first polymer based layer and the
2 second polymer based layer are provided at room temperature using chemical vapor
3 deposition of Parylene.

1 72. The device of claim 40 wherein
2 the first capacitor electrode includes a first plurality of electrode elements;
3 the second capacitor electrode includes a second plurality of electrode
4 elements;
5 each of the first plurality of electrode elements and the second plurality of
6 electrode elements is associated with a width ranging from 1 to 100 microns.

1 73. The device of claim 40 wherein
2 the first capacitor electrode includes a first electrode element;
3 the second capacitor electrode includes a second electrode element;
4 the first electrode element is adjacent to the second electrode element;
5 the first electrode element is physically separated from the second electrode
6 element by a spacing distance;
7 the spacing distance ranges from 1 to 100 microns.